

Applied Quantitative Finance

Mauricio Garita

Applied Quantitative Finance

Using Python for Financial Analysis

palgrave
macmillan

Mauricio Garita
Universidad Francisco Marroquín
Guatemala City, Guatemala

ISBN 978-3-030-29140-2 ISBN 978-3-030-29141-9 (eBook)
<https://doi.org/10.1007/978-3-030-29141-9>

© The Editor(s) (if applicable) and The Author(s) 2021

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use. The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Cover illustration: © Melisa Hasan

This Palgrave Pivot imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*I want to thank God, my wife Sonia, Mikel and Maia for being the reason
for keeping moving forward.*

INTRODUCTION

This book is aimed for students, professionals, academics and everyone who wants to learn Python and its application to the stock market. Therefore, the book begins with the simple implementation of Python, advances to statistical methods and ultimately reaches the creation of portfolios.

The book also provides a clear understanding of the different discussions that surge between academic and professional world in the area of finance. As the reader will see, there are references throughout the book so that the learning experience may continue after the book is finished.

When considering the different aspects of programming the author centered on the writing of the code as a whole, so that it can be followed by the reader. This allows a better learning and an implementation of the process by the reader, giving a better knowledge about the process, the errors and how to implement solutions.

As a final note, this book does not aim to be a in-depth finance book or programming book. This book is written from a practitioner point of view from finance using programming. The reader should see and analyze this book from a practitioner perspective, with the purpose of learning the application of different statistical, mathematical and financial concepts in the growing language that is Python.

As an author, this book is an effort to close an important gap for those interested in financial programming and I hope that it opens the doors to new possibilities.

WHAT THIS BOOK IS AND IS NOT

This book is not a theoretical book that will explain each and every detail of each indicator presented. This book centers in applying finance to the different indicators to offer a hands-on experience.

This book does not cover all the aspects of finance. For example, the book is centered in technical, quantitative and risk analysis of the stock market, but it does not cover each and every avenue. This book does not contain options and futures, Montecarlo Simulations and binomial trees. The reason is that this book aims to be an introductory to intermediate level. Considering advanced level there are books far more detailed on this aspects.

This book does not aim to explain programming language to the reader. It explains the easiest way to program a portfolio, a MACD, a VaR and other financial instruments. Also, the code is simple and clean so that the reader is not overwhelmed by programming. I truly believe that we can learn to program if we start from the basics and this book aims for this.

This book does not aim to be perfect. Its aim is to open a discussion considering finance and the growth of the different methods of the internet. Therefore, the book is explained through Yahoo API because it is the present live information at every second. Even though, everything can be elaborated in Excel after uploading the document to Jupyter notebooks or Google Collaboratory.

Finally, during the writing of this book, I began reading different scripts from different authors trying to find the easiest way possible to understand Python. This book is an effort to make things simple.

Thank you for believing in this book. Thank you for giving it the opportunity of being in your hands, in your reading, supporting your future. This book is a tool that I wish I had at the beginning of my career. Simple enough to understand but solid enough to be reliable.

Sincerely, Mauricio Garita

CONTENTS

Why Python?	1
<i>Installing Python in the Computer</i>	4
<i>Using Jupyter Notebooks with Python</i>	6
<i>Understanding Jupyter Notebooks</i>	7
<i>Using Google Colab</i>	14
<i>References</i>	17
Learning to Use Python: The Basic Aspects	19
<i>Understanding Numbers in Python</i>	20
<i>Understanding Numbers in Python</i>	21
<i>Using Data Structures in Python</i>	25
<i>What Is a List?</i>	25
<i>How to Create a List?</i>	25
<i>Indexing and Cutting a List</i>	27
<i>Appending Lists</i>	32
<i>Arranging Lists</i>	32
<i>From List to Matrices</i>	33
<i>From List to Dictionaries</i>	33
<i>Modifying a Dictionary</i>	35
<i>Other Interesting Functions of a Dictionary</i>	35
<i>The DataFrame</i>	36
<i>Boolean, Loops and Other Features</i>	42
<i>If, Else and Elif in Python</i>	44

<i>Loops</i>	46
<i>For Loop</i>	46
<i>While Loop</i>	52
<i>List Comprehension</i>	55
<i>References</i>	57
 Using FRED® API for Economic Indicators and Data (Example)	59
<i>Installing the FRED® API</i>	59
<i>Using the FRED® API to Retrieve Data</i>	60
<i>First Step</i>	60
<i>Second Step</i>	60
<i>Third Step</i>	60
<i>The Gross Domestic Product</i>	63
<i>The Gross Domestic Product Price Deflator</i>	65
<i>Understanding the Process into the Basics</i>	66
<i>Comparing GDP</i>	67
 Using Stock Market Data in Python	71
<i>API Sources</i>	71
<i>Most Important Libraries for Using Data in Python in the Present Book</i>	72
<i>Other Important Libraries Not Used in This Book</i>	74
<i>Suggestion of Libraries for Other Applications</i>	74
<i>Using Python with Yahoo Finance API</i>	75
<i>Using Python with Quandl API</i>	77
<i>Using f.fn() for Retrieving Information</i>	79
<i>Using Python with Excel</i>	81
<i>Conclusion Regarding Using Data in Python</i>	83
 Statistical Methods Using Python for Analyzing Stocks	85
<i>The Central Limit Theorem</i>	85
<i>Creating a Histogram</i>	88
<i>Creating a Histogram with Line Plots</i>	94
<i>Histograms Using f.fn()</i>	96
<i>Histogram (Percent Change) with Two Variables</i>	96
<i>Histogram (Logarithmic Return) with Two Variables</i>	98
<i>Interquartile Range and Boxplots</i>	99
<i>Boxplot with Two Variables</i>	102
<i>Kernel Density Plot and Volatility</i>	104

<i>Kernel Density Plot (Percent Change) with Two Variables</i>	108
<i>Covariance and Correlation</i>	109
<i>Scatterplots and Heatmaps</i>	113
<i>Works Cited</i>	117
 Elements for Technical Analysis Using Python	 119
<i>The Linear Plot with One Stock Price (Max & Min Values and the Range)</i>	119
<i>When to Use Linear Plots in Finance</i>	123
<i>The Linear Plot with Two or More Stock Price</i>	123
<i>Linear Plot with Volume</i>	126
<i>Volume of Trade</i>	128
<i>Comparison of Securities with Volume Plots and Closing Prices</i>	129
<i>Candlestick Charts</i>	133
<i>Candlestick Charts and Volume</i>	136
<i>Customizing Candlestick Charts and Volume with **Kwarg</i>	138
<i>OHLC Charts with Volume</i>	138
<i>Line Charts with Volume</i>	140
<i>Moving Average with Matplotlib</i>	142
<i>Moving Average with Mplfinance</i>	147
<i>The Exponential Moving Average (EMA)</i>	149
<i>The Moving Average Convergence Divergence (MACD) with Baseline</i>	153
<i>The Moving Average Convergence Divergence (MACD) with Signal Line</i>	157
<i>Bollinger Bands[®]</i>	160
<i>Backtesting Strategies for Trading</i>	162
<i>Parabolic SAR</i>	162
<i>Fast and Slow Stochastic Oscillators</i>	165
<i>References</i>	169
 Valuation and Risk Models with Stocks	 171
<i>Creating a Portfolio</i>	171
<i>Calculating Statistical Measures on a Portfolio</i>	174
<i>The Capital Asset Pricing Model</i>	176
<i>The Beta</i>	176
<i>The Beta and the CAPM</i>	182
<i>Sharpe Ratio</i>	188
<i>Traynor Ratio</i>	194

<i>Jensen's Measure</i>	197
<i>Information Ratio</i>	201
<i>References</i>	209
Value at Risk	211
<i>Historical VaR (95)</i>	211
<i>Historical VaR (99)</i>	213
<i>VaR for the Next 10 Days</i>	214
<i>Historical Drawdown</i>	218
<i>Wrapping Up the Book—Understanding Performance</i>	222
<i>Portfolio Performance using f.fn()</i>	222
<i>Fund Performance using f.fn()</i>	226
<i>Works Cited</i>	234
Works Cited	235
Index	239

ABOUT THE AUTHOR

Mauricio Garita began his studies at the Universidad Rafael Landivar in Guatemala studying Economics and Business Administration. Once he graduated, he went to Manchester Business School to study a master's in international business and to el Instituto de Estudios Bursátiles (IEB) to study a master's in asset management. He received his Ph.D. from the Pontificia Universidad de Salamanca focusing in Sociology and Politics writing his thesis on the economic impact of the Civil War in Guatemala.

He has worked with the office of the World Bank in Guatemala focusing on financial and economic aspects, he directed the Department of Business Intelligence in the Secretariat for Central American Economic Integration (SIECA) and the Department of Business Intelligence of the Private Sector (CACIF) at Guatemala. He also created the Department of Academic Relations at the Central American Institute of Fiscal Studies (ICEFI).

In academics, Mauricio has taught at a masters and bachelors level courses focused on economics and finance at the Universidad Rafael Landivar, Universidad del Valle, Universidad del Istmo and lately at Universidad Francisco Marroquin. He was part of the founders of the master's in advanced finance at the Universidad del Valle in Guatemala and researcher and professor in finance at Universidad Francisco Marroquin.

On a business level, he founded Simpleconomics which centers on personal and business finance combined with philosophical views from the stoic philosophy. He is one of the founders of the Stoic Chapter

in Guatemala. He also created a *podcast* with the name *Simpleconomics* which is a podcast focused on finance and philosophy.

His research can be read in Business and Politics, Emerging Economies and Multinational journals to name a few, in the Routledge book written in collaboration with John Spillan and Nichols Virzi, in the Rethinking Taxation in Latin America book by Palgrave Macmillan and in newspapers such as Prensa Libre of Guatemala and the economic magazines such as El Economista and Estrategia y Negocios for Central America.

LIST OF FIGURES

Why Python?

Fig. 1	Comparison between R and Python (<i>Source</i> [Pfeiffer 2019])	3
Fig. 2	Jupyter Notebooks (<i>Source</i> Obtained from the computer of the author)	8
Fig. 3	Jupyter Notebook—selecting Python (<i>Source</i> Obtained from the computer of the author)	9
Fig. 4	Creating a folder (<i>Source</i> Obtained from the computer of the author)	10
Fig. 5	A sample of Jupyter Notebooks (<i>Source</i> Obtained from the computer of the author)	10
Fig. 6	Installing a package (<i>Source</i> Obtained from the computer of the author)	12
Fig. 7	Selecting package to install (<i>Source</i> Obtained from the computer of the author)	12
Fig. 8	Searching for a package (<i>Source</i> Obtained from the computer of the author)	13
Fig. 9	Process of installing a package (<i>Source</i> Obtained from the computer of the author)	14
Fig. 10	Creating a new Colab document	15
Fig. 11	Google Colaboratory	16
Fig. 12	Changing name to notebook in Google Colab	16
Fig. 13	Accessing Google Colab documents	16

Using Stock Market Data in Python

Fig. 1	Example of the retrieval of data from Tesla (<i>Source</i> Obtained from the computer of the author)	77
Fig. 2	Petroleum Prices using Quandl (<i>Source</i> Elaborated by the author with information from Quandl)	78

Statistical Methods Using Python for Analyzing Stocks

Fig. 1	IBM results using describe	88
Fig. 2	IBM Returns Frequency (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	90
Fig. 3	IBM histogram with 40 bins (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	91
Fig. 4	IBM frequency using f.fn()	91
Fig. 5	IBM histogram with logarithmic returns (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	93
Fig. 6	IBM frequency using f.fn() with logarithmic returns	93
Fig. 7	IBM Returns with axvline (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	94
Fig. 8	Coca-Cola and Pepsi percent change Histogram (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	97
Fig. 9	Coca-Cola and Pepsi logarithmic histogram (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	98
Fig. 10	IBM Boxplot (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	102
Fig. 11	Coca-Cola and Pepsi box-plots (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	103
Fig. 12	IBM KDE with log returns (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	107
Fig. 13	Coca-Cola and Pepsi KDE (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	108
Fig. 14	Scatter Matrix of Nutanix and SP500 (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	114
Fig. 15	Nutanix and SP500 Scatterplot (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	115
Fig. 16	Nutanix and SP500 Heatmap (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	115

Elements for Technical Analysis Using Python

Fig. 1	Tesla closing price using Python (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	121
Fig. 2	Tesla Closing price with different size (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	121
Fig. 3	Comparison of closing prices in Airline Industry (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	125
Fig. 4	Setting the legend with shadow, framealpha, fancybox and borderpad (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	126
Fig. 5	Comparison of Volume and Closing price of Tesla (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	127
Fig. 6	Total Traded Plot (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	129
Fig. 7	Volume traded of Tesla, General Motors and Ford (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	131
Fig. 8	Closing Price of Ford, General Motors and Tesla (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	131
Fig. 9	Comparison of volume and closing price of Ford (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	132
Fig. 10	Understanding volume and price with Ford Security (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	133
Fig. 11	Candlestick bar representation (<i>Source</i> Created by Bang [2019])	134
Fig. 12	Zoom candlestick chart (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	135
Fig. 13	Dow Jones Candlestick chart with volume (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	137
Fig. 14	Candlestick chart and volume chart using colors (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	139
Fig. 15	OHLC bars explained (<i>Source</i> From the article written by Basurto [2020])	139

Fig. 16	Dow Jones OHLC chart with volume (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	141
Fig. 17	Line charts with volume (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	142
Fig. 18	Simple moving average of Walmart (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	145
Fig. 19	Simple moving average of Target (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	146
Fig. 20	Simple moving average of Amazon (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	147
Fig. 21	Simple moving average for Walmart (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	148
Fig. 22	Amazon EMA 50, 100, 200 (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	151
Fig. 23	Target EMA 50, 100,200 (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	151
Fig. 24	Walmart EMA 50, 100,200 (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	152
Fig. 25	Amazon MACD with Baseline (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	155
Fig. 26	Walmart MACD with Baseline (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	156
Fig. 27	Target MACD with baseline (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	156
Fig. 28	MACD and Signal Line (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	159
Fig. 29	Dow Jones Bollinger Bands (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	162
Fig. 30	AAPL Parabolic SAR	164
Fig. 31	Slow stochastic oscillator	168
Fig. 32	Fast stochastic oscillator	169

Valuation and Risk Models with Stocks

Fig. 1	Cumulative returns of the portfolio (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	185
Fig. 2	Comparing Benchmark and Portfolio (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	191
Fig. 3	Correlation plot between Portfolio and Benchmark (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	193

Fig. 4	Comparsion between portfolio and benchmark (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	197
Fig. 5	Total position of the portfolio (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	207
Fig. 6	Position behavior on each security (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	208

Value at Risk

Fig. 1	Cumulative Return of the portfolio (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	220
Fig. 2	Drawdown of the portfolio (<i>Source</i> Elaborated by the author with information from Yahoo Finance)	222
Fig. 3	MSAUX SMA	227
Fig. 4	MSAUX EMA	228
Fig. 5	MSAUX Bollinger Bands	229
Fig. 6	MSAUX RSI	230
Fig. 7	Rebase of the closing price in funds and ETF	232
Fig. 8	Funds and ETF monthly progression	232

LIST OF TABLES

Learning to Use Python: The Basic Aspects

Table 1	Understanding operators	43
---------	-------------------------	----

Elements for Technical Analysis Using Python

Table 1	Closing time in stock markets	165
---------	-------------------------------	-----

Valuation and Risk Models with Stocks

Table 1	Shares outstanding of Tesla, Netflix, Amazon and Walt Disney	173
Table 2	Market capitalization of Netflix, Tesla, Amazon and Walt Disney	173
Table 3	Market capitalization and portfolio weight	174
Table 4	The Beta Table	181
Table 5	Investing USD 500,000	183
Table 6	Alpha decision making	201

LIST OF EQUATIONS

Statistical Methods Using Python for Analyzing Stocks

Equation 1	Population mean	86
Equation 2	Sample mean	86
Equation 3	Total security return	89
Equation 4	Sturges rule	89
Equation 5	Logarithmic return equation	92
Equation 6	IQR formula	100
Equation 7	Variance formula	104
Equation 8	Standard deviation equation	105
Equation 9	Kernel density estimation—weighting	106
Equation 10	Covariance	110
Equation 11	Correlation	111

Elements for Technical Analysis Using Python

Equation 1	Total Money Traded	128
Equation 2	MACD equation with EMA	154
Equation 3	Uptrend and Downtrend SAR Equation	162
Equation 4	Fast Stochastic Oscillator Equation	165

Valuation and Risk Models with Stocks

Equation 1	Portfolio standard deviation	174
Equation 2	Total risk	176
Equation 3	Beta calculation with correlation	176

Equation 4	Beta calculation with covariance	177
Equation 5	Excess return	182
Equation 6	Capital Asset Pricing Model	182
Equation 7	Portfolio Return	184
Equation 8	Real Risk	186
Equation 9	Beta calculation with covariance	187
Equation 10	Sharpe Ratio	189
Equation 11	Traynor Ratio	194
Equation 12	Jensen's measure	198

Value at Risk

Equation 1	Value at Risk - position	216
------------	--------------------------	-----